Thoughts on Renewable Energy Forecasting Research Opportunities

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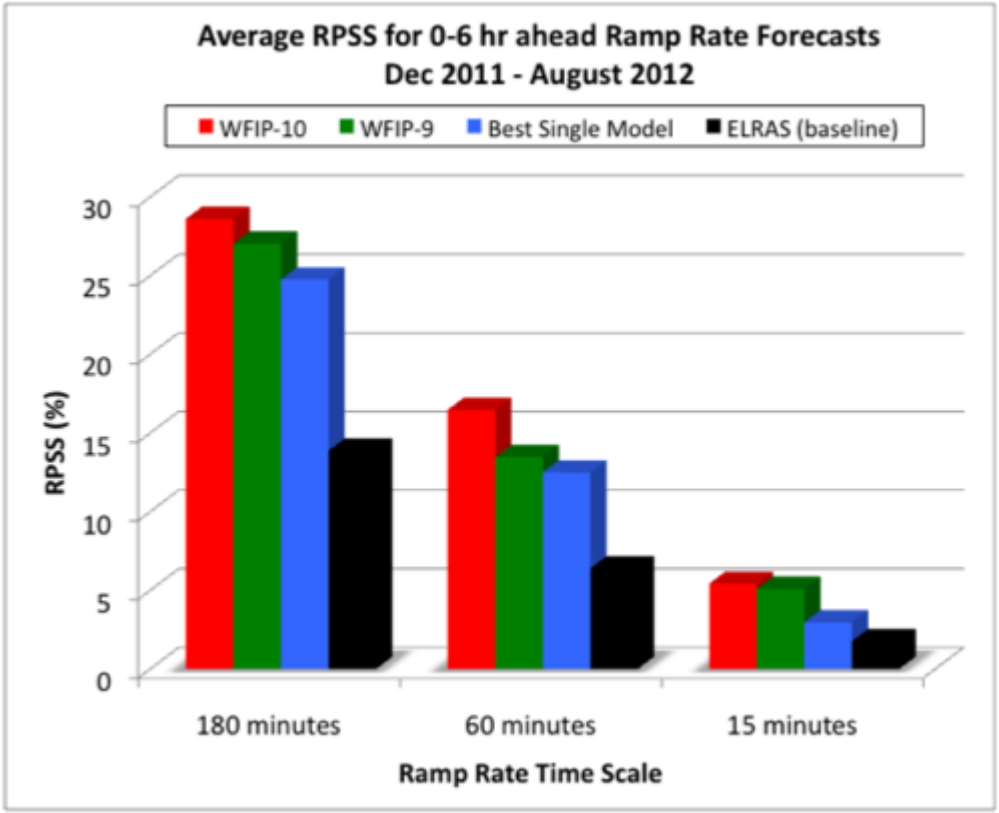
Point 1: What should be the target of forecasting research? The most frequent user response

- More accurate prediction of ramps (wind gen, solar gen, implicitly net load)
  - » Timing
  - » Amplitude
  - » Duration
- Challenges
  - » Definition of a ramp: some form of large change in short time periods
  - » Time scales
    - Largest changes on the shortest time scales are most critical
    - These have the lowest predictability
  - » Ramps are caused by a variety of physical processes
    - Dominant processes vary by resource type, location, weather regime, etc.
    - Implication: The relevant NWP physics, NWP DA and statistical predictors vary
  - » The limiting factor on ramp forecast performance is probably situation-dependent
  - » The “what is desired and what is measured (rewarded)” issue

Ramp Predictability by Time Scale: Example from ERCOT

- For 0-6 hour look-ahead period for system-wide aggregate in Texas:
  - 3-hr ramps have 2 X the predictability of 1-hr ramps
  - 3-hr ramps have 6 X the predictability of 15-minute ramps
  - Very little skill in the prediction of 15-minute ramps
- To improve this: need better observations, data assimilation and modeling of small-scale atmospheric features

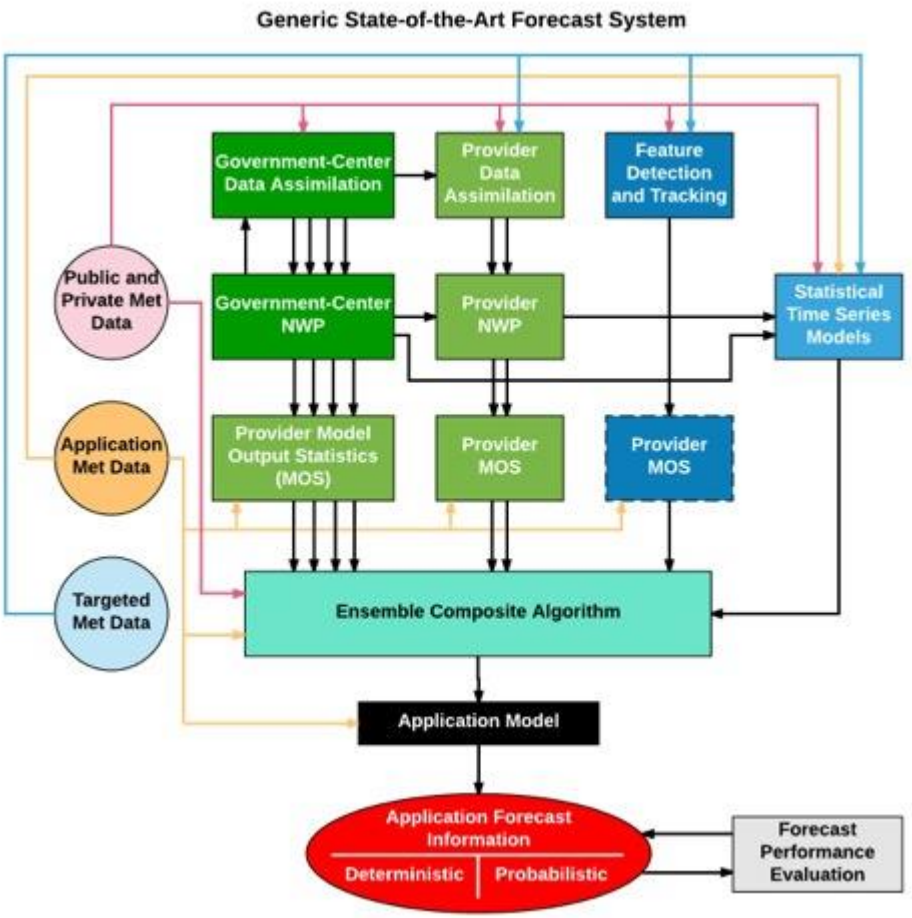


RPSS: higher values = better performance
RPSS measure probabilistic forecast skill relative to climatological probabilities

Results for ERCOT system-wide aggregate from the WFIP-1 wind forecasting project supported by DOE

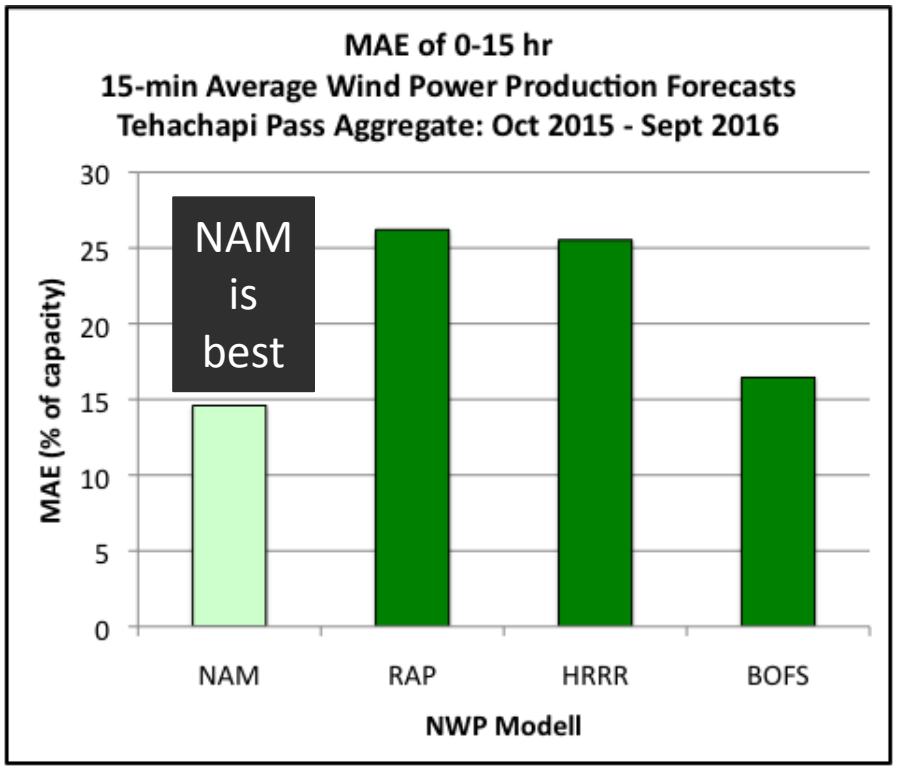
What are the limiting factors in (ramp) forecast performance ?

- Current state-of-art forecasts are a composite of a set (ensemble) of forecasts from many methods and data inputs
  - » Multiple scales of NWP models
  - » Feature tracking models (e.g. cloud advection for solar forecasts)
  - » Statistical time series models
  - » Application models
- Each method typically has scenario-specific (look-ahead time, application weather regime etc.) strengths and weaknesses
- An ensemble composite yields the best results over a large sample – but how do you obtain the best in specific scenarios?



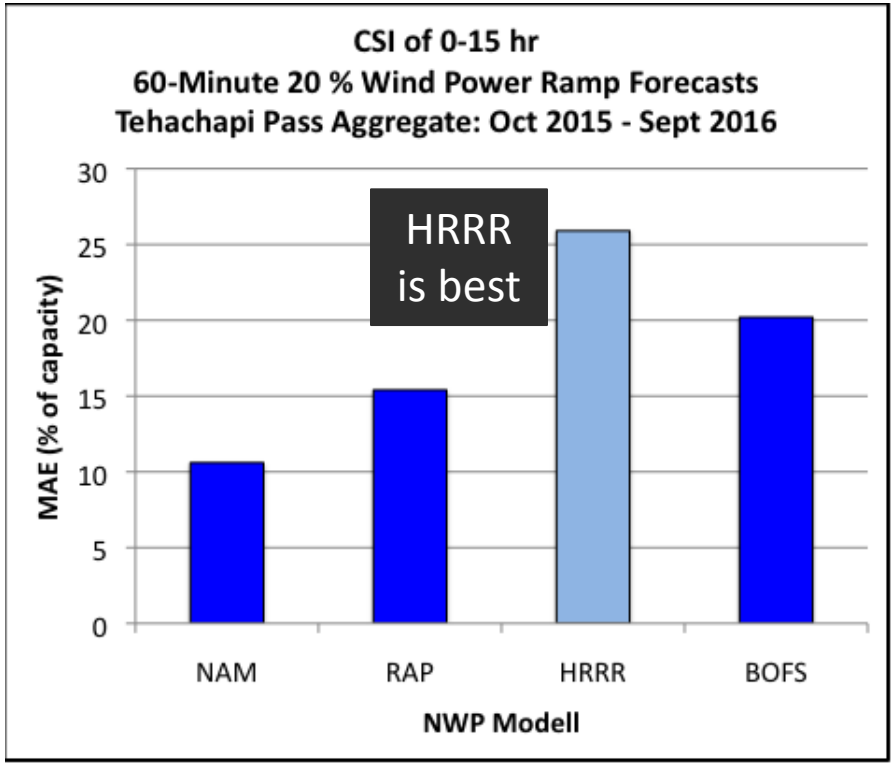
What is Usually Measured and What is Desired

Users typically measure this….



MAE: lower values = better performance

Although they say they want this….

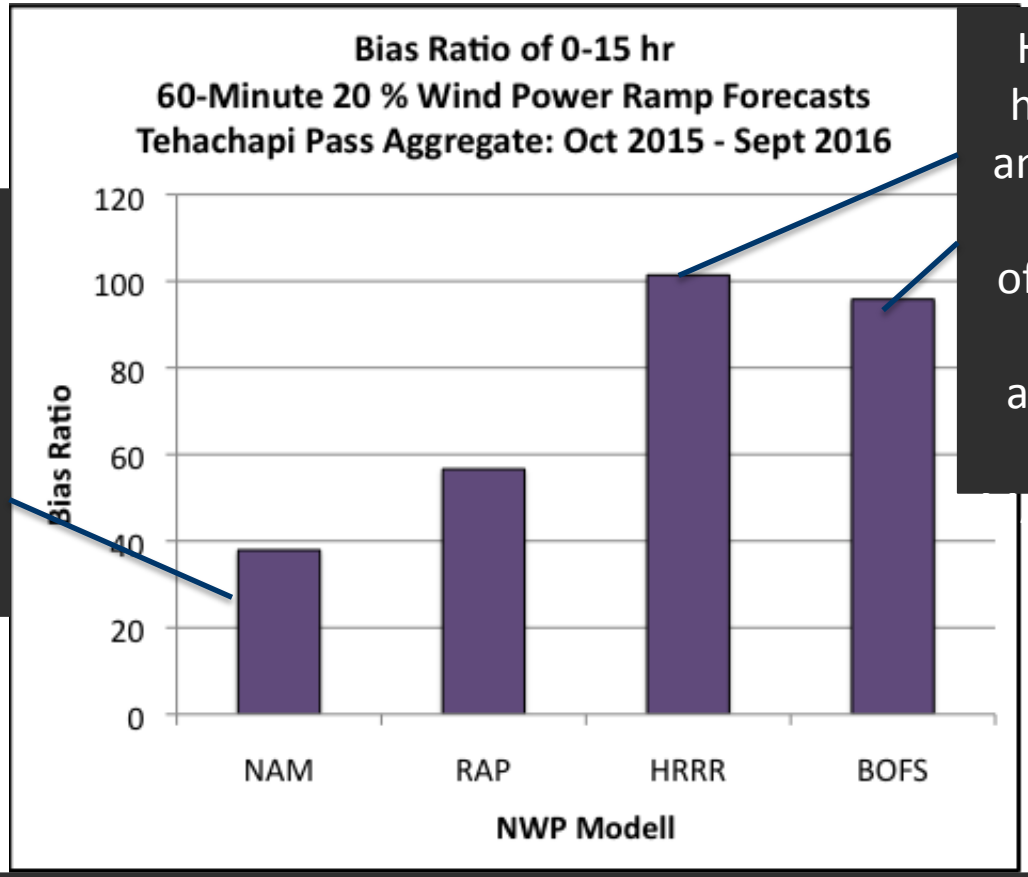


CSI: higher values = better performance
Note: +/- 2-hour “hit” window

Results from the Tehachapi wind forecasting project supported by CEC and EPRI

The Performance Difference: Insight and Implications

NAM drastically underestimates the 80-min variability which results in implicit "hedging" and better MAE & RMSE



HRRR and BOFS have the correct amount of 60-min variability but often get specific timing and amplitude which gives then a

Implication: Forecasts of short time-scale (e.g. 60 min) ramps have a lot of uncertainty (but still have useful information) and are much better done in a probabilistic mode

Results from the Tehachapi wind forecasting project supported by CEC and EPRI

Point 2: What Few Users Request: Probabilistic Information

- Key Concept: Forecasts are themselves a variable resource
  - » Uncertainty is variable and may have a complex structure
  - » Uncertainty is represented by a probability distribution
  - » Uncertainty is also present in other parts of the grid system
  - » Uncertainty estimates vary in quality: reliability, resolution, sharpness etc.
- Issue: Uncertainty information is often under-utilized, ignored by the user or not even presented to the user.